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Review

Balancing the risks to individual and society: a systematic review and synthesis of qualitative research on antibiotic prescribing behaviour in hospitals

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SUMMARY

Background: Antimicrobial resistance is a global health threat, partly driven by inappropriate antibiotic prescriptions for acute medical patients in hospitals.
Aim: To provide a systematic review of qualitative research on antibiotic prescribing decisions in hospitals worldwide, including broad-spectrum antibiotic use.
Methods: A systematic search of qualitative research on antibiotic prescribing for adult hospital patients published between 2007 and 2017 was conducted. Drawing on the Health Belief Model, a framework synthesis was conducted to assess threat perceptions associated with antimicrobial resistance, and perceived benefits and barriers associated with antibiotic stewardship.
Findings: The risk of antimicrobial resistance was generally perceived to be serious, but the abstract and long-term nature of its consequences led physicians to doubt personal susceptibility. While prescribers believed in the benefits of optimizing prescribing, the direct link between over-prescribing and antimicrobial resistance was questioned, and prescribers' behaviour change was frequently considered futile when fighting the complex problem of antimicrobial resistance. The salience of individual patient risks was a key barrier to more conservative prescribing. Physicians perceived broad-spectrum antibiotics to be effective and low risk; prescribing broad-spectrum antibiotics involved low cognitive demand and enabled physicians to manage patient expectations. Antibiotic prescribing decisions in low-income countries were shaped by a context of heightened uncertainty and risk due to poor microbiology and infection control services.
Conclusions: When tackling antimicrobial resistance, the tensions between immediate individual risks and long-term collective risks need to be taken into account. Efforts to reduce diagnostic uncertainty and to change risk perceptions will be critical in shifting practice.

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Background

Antimicrobial resistance (AMR) is a global problem forecast to cost more than 10 million lives by 2050 [1]. All antibiotic use contributes to the development of resistance, and while some stewardship activities have been successful in reducing antibiotic prescriptions in the community, hospital prescriptions remain on the rise. In the UK, for example, the overall quantity of antibiotics given to hospital inpatients increased by 5.7% from 2013 to 2014 [2]. Globally, up to half of all antibiotic prescriptions for acute medical patients in hospitals are estimated to be inappropriate [3,4]. Inappropriate prescribing includes prescribing antibiotics when they are not medically indicated (e.g. for viral illnesses) or prescribing antibiotics for an inappropriate length of time. An additional problem is unnecessary prescribing of antibiotics in situations where infections may clear without drug treatment (e.g. bacterial infections of the throat, including pharyngitis). Finally, inappropriate prescribing can refer to the excessive prescribing of broad-spectrum antibiotics (BSAs), which are effective against a wider range of pathogens compared with more narrow-spectrum antibiotics (NSAs), and as a consequence are stronger drivers of AMR [5]. Efforts to address the growing problem of AMR often target individual prescriber behaviour change, with a focus on optimizing antibiotic prescribing to reduce over-use and inappropriate use of antibiotics.

The complexity of changing prescribing behaviour is reflected in findings from a review of qualitative literature on doctors' antibiotic prescribing decisions across primary and secondary care, which identified many intrinsic and extrinsic factors influencing antibiotic prescribing. These included knowledge and attitudes, sociodemographic factors, patient-related factors and healthcare-system-related factors [6]. An important but under-theorized aspect of the problem of changing prescribing behaviours is the role of risk perceptions [7]. Medical practice generally involves working practices that are framed by concepts of risk [8], with practitioner behaviours underpinned by work to minimize risks to both patients and practitioners. Understanding perception of (relative) risks, and how these risks are classified, oriented to and managed in decision-making processes, is arguably critical for successful interventions to promote behaviour change [9,10].

This paper reports a systematic review and framework analysis of qualitative literature on antibiotic prescribing in hospitals, with an explicit focus on risk perceptions. The Health Belief Model (HBM) is used as a framework for the analysis [11–13]. Over the years, repeated evidence has suggested that this model can explain and predict health-related behaviour reliably [11,14]. Additional validation of the HBM has been provided by studies using the model successfully to design effective health behaviour interventions [15]. The HBM suggests that perceptions of risks and benefits are crucial determinants of health-related behaviours and behaviour change. Particular risk-related aspects include the perceived threat of a health risk, jointly determined by the apparent susceptibility and severity of the risk in question, and the cost–benefit ratio of preventive action including the perceived effectiveness of a preventative behaviour and the personal costs or barriers associated with engaging in it (see Figure 1). The HBM has previously been applied to characterizing patient and physician perceptions of the threat of AMR, and benefits and barriers to engagement with antimicrobial stewardship [16,17].

This analysis addressed the research questions:

(1) How are the risks of AMR perceived by prescribers in hospital settings?
(2) What are the perceived benefits of efforts to optimize antibiotic prescribing behaviour in hospitals, as a strategy to manage the risk of AMR?
(3) How do perceptions of risk act as facilitators or barriers to efforts to optimize antibiotic prescribing?

Methods

Information sources and search methodology

A systematic literature search of PubMed and Medline was undertaken for literature published over the past decade (i.e. between 2007 and 2017). This time frame was chosen to ensure that the empirical findings reviewed were still relevant to present-day hospital situations. The following broad search terms were used: '((antibiotic* OR antimicrobial) AND hospital)'. Filters were applied for qualitative studies (http://guides.lib.uw.edu/hsl/qualres/pubmed; http://libguides.sph.uth.tmc.edu/search_filters/ovid_medline_filters). An initial search was conducted in August 2017, and the search was re-run in January 2018.

Inclusion criteria

All articles identified through the search were screened against the following inclusion criteria: (a) reports primary data; (b) includes findings from qualitative research (e.g. interviews; focus groups; observations); (c) focuses on existing approaches to decision-making about antibiotic prescribing, rather than describing or evaluating new antibiotic stewardship interventions; (d) uses samples of physicians or healthcare workers (rather than patients or managers); and (e) reports data collected in adult secondary and tertiary healthcare settings. Paediatric prescribing for children and neonates was excluded from the review because children typically show different antibiotic resistance levels, and their prescribing guidelines differ from adult guidelines (e.g. pertaining to duration of antibiotics). Articles that focused on surgical prophylaxis were also excluded. To avoid losing studies that could provide important insights, no exclusions were made on the basis of quality [18]; no study that met the inclusion criteria was deemed to be fatally flawed, although some papers provided more findings that were relevant to the research questions, and so were more heavily weighted in the analysis than others [19].

Analysis

A framework-based synthesis approach was used to analyse and synthesize the qualitative studies [20]. Under this approach, analysis uses existing models or theories to create the framework for the synthesis; this is coupled with inductive, thematic analysis techniques to capture the complexity of the data in full. Analysis involved coding all data in the results section of each paper to a coding scheme based on the four

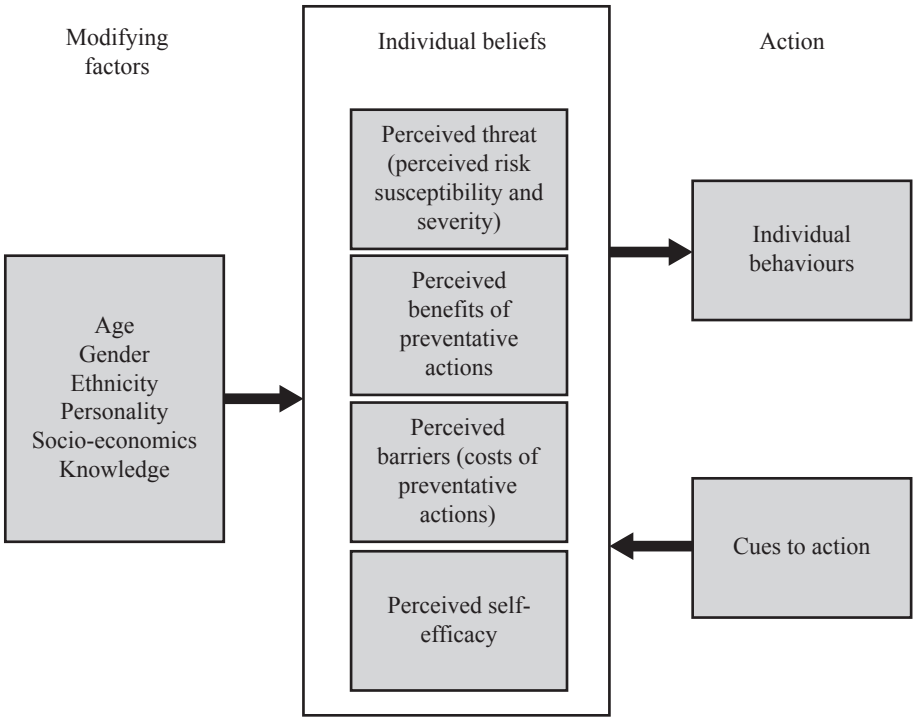

Figure 1. Diagram of Health Belief Model adapted from Glanz *et al.* (2015).

different risk-related aspects of the HBM: (a) susceptibility to risk; (b) severity of risk; (c) effectiveness of preventative action; and (d) barriers to engagement in preventative action. Perceptions of risks and preventative actions related to societal outcomes (AMR) were coded, as well as other risks related to antibiotic prescribing decisions including individual patient outcomes (e.g. morbidity) and risks to prescribers. The coding frame was developed iteratively during coding to reflect emergent themes.

Results

In total, 775 articles were identified, and 34 articles were found to meet the inclusion criteria for the present review. Details of included articles are shown in Table I. The majority of the included studies involved research with senior or junior doctors. Twelve articles reported findings from Australia, seven from the UK and three from the USA. Only six studies reporting relevant qualitative findings from low and middle income countries (LMICs) (Cambodia, India, Ghana, Sri Lanka, China and Vietnam) were identified. The vast majority of studies ($N = 25$) used interviews, five studies employed focus groups, and the rest adopted a combination of qualitative methods.

This article presents the results from the framework synthesis, providing an overview of the evidence on perceived severity of, and susceptibility to, the consequences of AMR in hospital settings, and describing perceived benefits and barriers to optimizing antibiotic prescribing behaviour in hospitals as a preventative action. Illustrative quotes for each theme are provided in Table II; all quotes are labelled with unique numbers. To link the quotes to the relevant text below, quote numbers are included in parentheses.

AMR as a health threat: perceived severity

Health professionals working in hospital settings are, on the whole, aware of the threat of AMR as a serious problem with potentially severe consequences (1a) [7,21]. They recognize the potential for AMR to pose a devastating global health threat — a future 'antibiotic apocalypse' [22] in which commonly used antibiotics would no longer be effective, and untreatable infections would be widespread. They also acknowledge that, in the shorter term, growing levels of resistance could make it more difficult to treat patients, with some patients not responding to first-line treatment but requiring protracted treatment with higher doses or multiple antibiotics (1b) [21,23], increasing the risk of negative patient outcomes as well as cost.

AMR as a health threat: perceived susceptibility

Despite widespread recognition of the risks of AMR, a common theme in the literature is that of low perceived susceptibility to these risks in the context of everyday practice. There is evidence that some staff are disinterested in the topic [24]. Staff tend not to see themselves as susceptible to the risks of resistance due to a lack of imminence and the abstract nature of their consequences (2a) [22,24]. So long as they can continue to treat patients effectively with antibiotics, AMR remains a distant problem that does not pose an immediate or pressing risk for themselves or their patients, and can be bracketed out as a source of worry [7,22,25–28]. This lack of perception of susceptibility is bolstered by a general lack of awareness of the current scale of resistance and of local resistance patterns (2b) [7,29].

Exceptions to these widespread perceptions of low perceived susceptibility come from accounts of staff who have

Table I
Overview and summary variables of all qualitative studies reviewed in this article (in alphabetical order of authors)

Authors	Country	Method	Sample		Focal topic
			Type	Size	
Almatar *et al.* (2014) [55]	Australia	Interviews	Different doctors	8	Antibiotic use for treating pneumonia
Asante *et al.* (2017) [21]	Ghana	Interviews	Multiple	33	Antibiotic prescribing in hospitals
Björkman *et al.* (2010) [24]	Sweden	Interviews	Different doctors	20	Identifying 'antibiotic prescriber types' of doctors
Broom *et al.* (2016) [44]	UK	Interviews	Different doctors	20	Intravenous to oral antibiotic switch
Broom *et al.* (2016) [42]*					Adherence to antibiotic prescribing guidelines and AMS
Broom *et al.* (2014) [7]	Australia	Interviews	Different doctors	30	Antibiotic prescribing in hospitals
Broom *et al.* (2015) [40]					
Broom *et al.* (2015a) [28]	Australia	Interviews	Pharmacists	19	Role of pharmacists in antibiotic prescribing
Broom *et al.* (2015b) [25]					
Broom *et al.* (2016) [27]*					
Broom *et al.* (2016) [26]	Australia	Interviews	Nurses	30	Role of nurses in antibiotic prescribing
Broom *et al.* (2017) [22]	UK	Interviews	Multiple	28	Antibiotic use in hospital pulmonary infections
Broom *et al.* (2017) [36]	Australia	Interviews	Different doctors	64	Antibiotic prescribing in hospitals
Broom *et al.* (2017) [43]	Australia	Interviews	Multiple	30	Antibiotic prescribing in remote settings
Broom *et al.* (2017) [52]	Australia	Focus groups	Multiple	29	Antibiotic prescribing in hospitals
Charani *et al.* (2013) [46]	UK	Interviews	Multiple	39	Prescribing etiquette as determinant of antibiotic prescribing
Cotta *et al.* (2015) [50]	Australia	Focus groups	Multiple	17	Adherence to antibiotic prescribing guidelines and AMS
Eyer *et al.* (2016) [39]	Switzerland	Interviews	Different doctors	21	Antibiotic use for treating asymptomatic bacteriuria
Livorsi *et al.* (2015) [38]	USA	Interviews	Different doctors	30	Antibiotic prescribing in hospitals
Livorsi *et al.* (2016) [53]	USA	Interviews	Different doctors	30	Adherence to antibiotic prescribing guidelines and AMS
Mattick *et al.* (2014) [56]	UK	Interviews	Junior doctors	33	Antibiotic prescribing in hospitals
May *et al.* (2014) [30]	USA	Mixed qualitative methods	Multiple	31	Antibiotic prescribing in hospitals
Nguyen *et al.* (2009) [37]	Vietnam	Mixed qualitative methods	Multiple	20	Antibiotic use for treating reproductive tract infections
Om *et al.* (2016) [34]	Cambodia	Focus groups	Different doctors	103	Antibiotic prescribing in hospitals
Ravi *et al.* (2017) [33]	India	Interviews	Senior doctors	5	Antibiotic prescribing in hospitals
Reynolds and McKee (2009) [23]	China	Interviews	Multiple	18	Antibiotic prescribing in hospitals
Rawson *et al.* (2016)	UK	Interviews	Different doctors	20	Mapping the decision pathway of acute infection management
Schouten *et al.* (2007) [54]	The Netherlands	Mixed qualitative methods	Multiple	24	Antibiotic use for treating pneumonia
Sedrak *et al.* (2017) [32]	Australia	Interviews	Senior doctors	10	Antibiotic use for treating pneumonia
Skodvin *et al.* (2015) [51]	Norway	Interviews	Different doctors	15	Antibiotic prescribing in hospitals
Tillekeratne *et al.* (2017) [29]	Sri Lanka	Interviews	Multiple	55	Antibiotic use for treating reproductive tract infections
Tonna *et al.* (2010) [35]	UK	Focus groups	Pharmacists	14	Role of pharmacists in antibiotic prescribing
Velasco *et al.* (2011) [31]	Germany	Focus groups	Different doctors	14	Antibiotic prescribing in hospitals
Warburton *et al.* (2014) [57]	UK	Mixed qualitative methods	Multiple	16	Intravenous to oral antibiotic switch

AMS, antimicrobial stewardship.
*The publications combined in this row draw on the same data set.

Table II
Example statements in support of the themes and subthemes identified by the framework analysis

	Theme	Subtheme	Quotes
AMR as a perceived threat	Severity	High perceived severity of AMR	(1a) 'That is the most dangerous thing that can happen to mankind. We may move to the last limit where we cannot get any antibiotics to treat certain diseases.' [21] (1b) 'Antibiotic dosages have risen greatly. This is because people have some substance in their bodies which can resist the drug. If [a patient] can be treated by one pill the first time, the second time it takes two pills and the third time three pills.' [23]
	Susceptibility	Low perceived personal susceptibility to negative consequences of AMR Perceived susceptibility heightened by personal experience of consequences of AMR	(2a) 'So [resistance] it's something, if something's not affecting you straightaway you tend to put it off and put it off and I think that's sort of what's happened, is what happens.' [28] (2b) 'We don't have the big picture, so we don't worry as much […] about resistance patterns, about community-wide use of antibiotics.' [7] (2c) 'I think people should be really worried about it [AMR]. I'm aware of it. […] Often you'll hear [people] look up sensitivities and talk about it and go, 'Oh my god, they're resistant to just about everything. There's nothing left,' and you're like, 'Oh s***'.' (Female, general medicine, clinical nurse)' [26] (2d) 'You know, we're seeing VRE, we're seeing MRSA, we are seeing these things, and we're seeing them more and more. […] And if you know that your antibiotic prescribing patterns potentially affect that, and all the pain that goes with it. Like my unit's closed again at the moment, because someone came over from [location] with VRE now I can't take anyone into my new unit until we clear it.' [7]
Perception of optimizing antibiotic use as a preventative action	Benefits	Optimizing antibiotic use perceived to have the potential to reduce AMR Scepticism about impact of targeting hospital prescribing Other issues seen as more critical to address in tackling AMR	(3a) 'Every day, doctors are not performing appropriately. We have made lots of mistakes with our antibioticprescribing.' [34] (3b) 'I think [stewardship is] something that helps us curb inappropriate antibiotic usage, and it's necessary in all hospitals, I think, private and public, yeah.' [32] (3c) 'I just think in the grand scheme of things how much effect is [antibiotic misuse] having, or how much protection of antibiotics and reduction of resistance is [stewardship] actually creating?' [25] (3d) 'Antibiotic resistance is possible because in Ghana .., you can go to any drug store and buy any antibiotics without any prescription or these days we don't know the source of medication that we are getting whether they are the correct or the fake ones. The efficacy level is questionable.' [21] (3e) 'We think our practice doesn't comply with infection control guidelines. […] When we know that our practices are not correct we use antibiotics immediately, and this continues over and over.' [34]
	Barriers		

AMR risk loosely coupled to prescribing decision Short-term risks of antibiotic prescribing decision for individual patient and prescriber take precedence Reliance on BSAs helps manage risk in conditions of uncertainty and requires less cognitive effort Decisions influenced by access to resources to manage risk and uncertainty	(4a) 'But actually, about antibiotic resistance, so far I have no experience. Just by treating patients very often, we give treatment for three or four days. After that sometimes they won't come to us. But bit difficult to assess whether they have developed antibiotic resistance or not.' [29] (4b) 'The clinician is ultimately responsible for the patient's care, so if something's not done. […].Well I'm responsible, […] if this person dies it's me that faces the consequences.' [42] (4c) 'I actually have been criticized by a staff because of not covering somebody [with antibiotics] …I was suspicious for endocarditis but they were clinically stable and so I wanted to get multiple blood cultures and monitor…The next morning I was pretty severely reamed out [(reprimanded)] for not covering the patient [with antibiotics], although the person did fine and did not have a bad clinical result.' (12, resident interview) [38] (4d) 'If I am not prescribing an antibiotic from the first day, sometimes it can be a bacterial one [infection], and on the second, third day the patient will get more severe symptoms and go to another practitioner. Then [the practitioner will say] 'this is pneumonia' and they will start [antibiotics]. […] Mother or some relative will say that this is the best physician [….] His treatment is much better than the other one, then the first person will get less respect. Because of competition, most of the time in the private sector, they use antibiotics.' [29] (4e) 'I think that we, because of uncertainty, may be somewhat more active. And for the same reason that we sometimes give more BSAs than they do for example at the department of infectious diseases […] When you do not know, you use something stronger.' [24] (4f) 'Ceftriaxone is a fire and forget weapon. Give it, then the patient gets better … and there are very rare major side effects acutely. I guess people think that they cover their back by giving ceftriaxone.' [55] (4g) 'Patients want 'quality' medicine. They don't say 'ceftri [ceftriaxone]' they just say that they want 'quality' medicine. With stronger medicine, they believe they recover faster.' [34] (4h) 'When it is 3:00 in the morning, depending on how busy you are, the easiest solution is to throw vancomycin and piperacillin-tazobactam at every patient because you do not have time to read the confusing guidelines that tell you 16 different things you would potentially do.' [38] (4i) 'Lab tests have their limitations. I think it is subjective because it requires quality reagents and skilled and well-trained technicians to read the result. Not many of our lab technicians have such qualifications.' [49]

AMT, antimicrobial resistance; BSAs, broad-spectrum antibiotics; VRE, vancomycin-resistant enterococci; MRSA, meticillin-resistant *Staphylococcus aureus*.

had direct evidence of how they or their hospital have been exposed to negative consequences arising from the growing problem of resistance. Evidence from clinical experience of cases where AMR is already posing a serious risk to patients or causing problems in practice, rather than just being an abstract future threat, is particularly powerful in promoting a heightened sense of susceptibility (2c, 2d) [7,26]. Concern about AMR also tends to be greater in individuals who have a direct interest and expertise in infections and microbiology, and thus a better understanding of the problem and the current extent of resistance in the clinical population [24,30,31].

Optimizing antibiotic prescribing behaviour: perceived effectiveness in reducing the risk of AMR

The majority of staff recognize that inappropriate use of antibiotics, and over-reliance on BSAs, are problematic, and accept that initiatives are needed within hospitals to try to rationalize antibiotic use and change prescriber behaviour (3a, 3b) [32,33]. In LMIC settings in particular, there is concern that levels of inappropriate antibiotic prescribing are high [34]. Optimizing antibiotic prescribing, to reduce antibiotic over-use, is seen as a legitimate aspiration in health care [21], and as potentially bringing additional benefits, including ensuring more appropriate patient care, and reducing costs and length of stay [35]. There is also some scepticism, however, about the extent of benefit in terms of reducing the spread of resistance that can be achieved through a focus on optimizing antibiotic prescribing practice within hospitals (3c) [28]. A belief in the benefits of this approach as a means of reducing the risk of resistance can be undermined by a lack of hard evidence that reducing prescribing in hospitals will reduce the spread of resistance, and a perception that the problem is too complex [26].

In addition, prescribers are not always convinced that they themselves, or their hospital, are part of the problem, and hence may not feel they have a responsibility to change their practice [7,22,32,36]. This issue is compounded by a lack of feedback to prescribers about the quality of their prescribing, and a lack of information about local prescribing and resistance patterns. Prescribers commonly argue that the main causes of resistance lie beyond over-prescribing of antibiotics in hospitals, and that other solutions will have more effect. The latter is a common theme in the literature from LMICs. In some LMIC contexts, patients can buy antibiotics or obtain them easily through informal channels outside of the hospital, resulting in unregulated antibiotic use, and there is widespread concern about the quality of antibiotics and under-dosing [21,23]. These issues are seen as major contributing factors to resistance, making any efforts to address the risk of growing resistance through curbing antibiotic prescribing in hospitals seem futile (3d). In addition, focusing on infection control is argued by some to be a more immediate and effective solution in the fight against resistance, due to the important role that infection control can play in reducing the spread of resistant bacteria [31,34]. In LMICs, where hygiene standards are perceived to be relatively low, efforts to reduce antibiotic prescribing are expected to be ineffective without improved hygiene and infection control, as staff feel compelled to prescribe antibiotics to avoid infections due to unclean environments and poor infection control practices (3e) [34,37].

Barriers to optimizing antibiotic prescribing behaviour

The literature included in this review focused overwhelmingly on exploring the barriers to changing antibiotic prescribing behaviours, which are multiple and varied. Two risk-related themes run through the literature and underpin many of the challenges to optimizing antibiotic prescribing behaviour: antibiotic over-prescribing reflects a trade-off between individual risks and societal risks; and reliance on the use of BSAs helps manage immediate risk in conditions of uncertainty, and minimizes cognitive effort.

Over-use of antibiotics: perceptions of immediate risk

A significant perceived barrier to individual prescriber behaviour change arises from the nature of the link between individual prescribing behaviour and AMR as an outcome. While the majority of staff are aware, in principle, that their antibiotic prescribing actions can contribute to AMR, in practice, the link between individual antibiotic prescribing decisions and AMR is not immediate or apparent. In the context of their everyday practice, the risk of AMR as an outcome is loosely coupled [9] to the discrete event of decision-making about antibiotic prescribing for an individual patient (4a). In contrast, the risks that loom large for prescribers in making antibiotic prescribing decisions relate more to the immediate consequences of their decisions for individual patient outcomes: outcomes which are tightly coupled to the doctor's actions, and potentially severe, and therefore strongly shape the decision-making process [36].

Decisions about whether or not to prescribe antibiotics are heavily influenced by fears of missing bacterial infections or sepsis, with potentially serious consequences for patients, including death [7,38–40]. The concern about the individual patient lies at the core of the medical profession; doctors feel strongly that they have a duty of care to their patients [41], and that they have a responsibility to make decisions that are most likely to lead to a positive outcome of the individual patient in front of them (4b) [42]. When doctors have any suspicion of infection, even if this is not confirmed by laboratory results, they may be unwilling to take the risk of holding off from treating a patient [39]. Furthermore, doctors consider local patient populations and adapt prescribing choices to particularities of their location. In the remote Australian outback, for example, where patient compliance of indigenous patient groups is low and attendance of follow-up medical appointments is rare, doctors frequently over-prescribe antibiotics to prevent any complications [43].

The consequences of antibiotic prescribing decisions for prescribers themselves are closely linked to patient outcomes. Doctors perceive themselves to be susceptible to risks associated with negative patient outcomes including complaints and litigation [36,38,44], damage to professional reputation or attracting disapproval from colleagues or supervisors [40,45,46], and emotional responses to patient complications [7]. Being seen to under-treat can in itself give rise to negative consequences for doctors, even if this ultimately has no impact on the patients' condition (4c) [38]. Doctors describe experiences of being criticized as a result of decisions not to treat [38]; in contrast, conservative antibiotic decision-making is rarely made visible or praised [39].

Considerations around risk are most salient for junior doctors, who typically report higher risk perceptions than senior

consultants, especially in situations with high clinical uncertainty [39], and often face the challenge of making prescribing decisions in the absence of senior support (e.g. during night shifts) [45]. Junior doctors are acutely sensitive to the need to develop and maintain their reputations as competent doctors, and to avoid being reprimanded by their seniors for delaying treatment or putting a patient at risk, and in situations of uncertainty, choosing to start antibiotics can seem to be the easiest and safest option [30,39]. Senior doctors' preferences and expectations, and local prescribing norms, [26,32,38,42,45] also shape junior doctors' prescribing decisions; junior doctors risk facing social sanctions associated with committing a so-called 'quasi-normative error' [47] if a decision not to prescribe, or to delay prescribing until microbiological results are available, is at odds with local norms and expectations.

Antibiotics also have latent functions [48] beyond the direct benefit of preventing patient morbidity. The interests of doctors are bound in to the service relationship of demand and supply, and antibiotic prescribing forms part of this relationship. Doctors can feel under pressure to give antibiotics to satisfy perceived patient and carer demand [34], and avoid the risk of damaging their relationships with patients and carers [7]. Protecting relationships with patients, and more importantly doctors' professional reputations, is important for doctors working in private healthcare systems, who may face risks of losing patients and income if patients are dissatisfied with not receiving antibiotics (4d) [29,30,32,34,38,39,45,49–51].

In making prescribing decisions under conditions of uncertainty, doctors may consciously consider the risks of prescribing (in particular, over-prescribing) antibiotics, including AMR, but the risks of negative patient outcomes and corresponding personal and professional risks that could arise from failing to treat with antibiotics are often more heavily weighted in the decision [7,38]. This leads doctors to adopt approaches of 'defensive medicine' [52]. Ultimately, concern about short-term risks, and desire for short-term benefit, tend to trump any concern about longer-term consequences for wider society.

Over-use of broad-spectrum antibiotics: managing uncertainty and reducing cognitive effort

Initial decision-making about whether or not to start an antibiotic is generally based on clinical judgement about whether an infection is likely, rather than on microbiological evidence of infection. The majority of antibiotic prescribing is empirical, and choice of antibiotic is underpinned by a desire to give a treatment with the best chance of success. Although over-use of BSAs can disproportionately contribute to resistance, in practice, these types of antibiotics are an attractive choice. They are seen to offer the best level of protection from various risks. The use of a BSA helps doctors feel reassured that they are 'covering all bases' [38], especially when they have concerns about infection but are uncertain about the potential source; whatever the cause of an infection, a BSA is likely to be effective (4e, 4f, 4g). The use of BSAs, seen as powerful and, in some cases, 'mythical' drugs [34,52], is typically considered by prescribers to outweigh any costs [38] and, particularly in LMIC settings, to enable them to satisfy perceived patient demand for strong and high-quality medication (4g) [21,29,34]. On the whole, BSAs appear to promise faster patient recovery [24,34] and preservation of hospital resources [23].

Taking into account the risks of under-treatment discussed above, doctors may consider the need to reduce reliance on BSAs, but concerns about the risk of choosing an NSA which may 'miss a bug' [38,53,54] and prove to be ineffective are more salient. Treating according to guidelines is seen to offer some protection against this risk [51], but requires that up-to-date guidelines are available and accessible, and that doctors have the time and motivation to engage with them. This tendency to rely on BSAs is reinforced for doctors who have personally experienced problems when targeted antibiotics resulted in negative patient outcomes [29,34,43,55]; this is another issue that is particularly prominent in the literature from LMIC settings.

As prescribing BSAs is seen as a low-risk and low-cost activity in the short term, the decision-making process may be afforded little priority or attention. In choosing a BSA, decision-making about treatment can be undertaken quickly and with little cognitive effort [7,36], avoiding the need for complex decision-making (4h) [30,38] or disturbing senior doctors or specialist prescribers for advice [22,56]. Choosing to prescribe antibiotics, particularly BSAs, under conditions of uncertainty is seen as a quick, safe [54,55] and effective way to start treatment [39] when doctors are under pressure or short of time (4h) (especially out of hours [7,32,38,55]), or when they lack expertise or confidence in antibiotic selection [24,34].

Microbiological testing is perceived to play an important role in reducing uncertainty, but samples are not always taken reliably prior to commencing antibiotic treatment, and results may be inconclusive or delayed beyond the point at which a treatment decision needs to be made. Antibiotic prescriptions do not always get reviewed, which is a particularly frequent problem at weekends [57]. Even when laboratory results are available, doctors are often unwilling to take the risk of stopping successful treatment with a BSA [45,53] or replacing it with an NSA, describing a belief that they should 'never change a winning team' [26,53]. In LMIC settings in particular, resources to reduce uncertainty and guide decision making are often lacking; lack of access to good-quality laboratory testing (4i), poor infrastructure and lack of engagement with testing [21,29,34,49], and insufficient training and information about diagnoses of infections [21,29,33,49] are common problems. A lack of access to appropriate prescribing guidelines [34,49] can also contribute to making it difficult for prescribers to make conservative and tailored prescribing decisions. Under these circumstances, prescribing decisions are routinely made as best guesses under conditions of uncertainty, where erring on the side of caution — over-prescribing of antibiotics and over-reliance on BSAs — is a rational response.

While the risks of optimizing antibiotic prescribing loomed large and presented significant barriers to behaviour change, few prescribers across the studies suggested specific facilitators for more appropriate use of BSAs. Prescribers across several studies emphasized the importance of expert input from antimicrobial pharmacists [28,35,38], and maintaining good relations with microbiology services [31,38,45]. Others suggested the need for an overall change of existing healthcare systems [24] and support for doctors to manage risk more effectively [51].

Discussion

This systematic review provides a new, theory-informed description of perceptions of risk in relation to AMR and

antibiotic use in hospitals, drawing on the HBM [11,12]: a core model which predicts that health-related behaviours only change if the health risks are perceived to be a serious threat and if these risks are thought to be manageable. Evidence from 34 qualitative studies across high-income countries and LMICs was used to identify themes in relation to risk and perceptions of preventative actions.

While AMR risk is generally perceived by hospital staff to be very severe, perceptions of personal susceptibility are limited. Staff report some scepticism about the potential benefits of targeting hospital antibiotic prescribing as a strategy for reducing the threat of AMR. Doctors' accounts demonstrate rational and contextually embedded reasons for antibiotic over-use and over-reliance on BSAs, arising from the need to make decisions under conditions of uncertainty, and to manage risks to patients and to themselves as professionals — risks which are seen as more immediate, pressing and visible than the future abstract threat of AMR. Prescribing antibiotics, particularly BSAs, is characterized as a quick and easy strategy to manage short-term risks and gain short-term benefit, with minimal cognitive demand.

At the core of the problem of unnecessary or inappropriate prescriptions of antibiotics lies the much-discussed social dilemma of two different stakeholders with mutually exclusive interests [58–60]. One stakeholder is the individual patient with a suspected bacterial infection, and the other stakeholder is global human society. Antibiotic use has a range of implications in terms of the interests and risks for individual patients, related risks and consequences for doctors as professionals, and longer-term consequences for society [61,62]. These findings provide a description of how prescribers weigh these risks, and illustrate how prescribing behaviour is heavily (and rationally) weighted towards the avoidance of tangible, immediate and short-term risks, at the cost of the potentially catastrophic, but abstract and uncertain, future outcome of widespread AMR. This prioritizing of short-term, concrete risks, and discounting of abstract future risks has long been recognized as a core feature of human psychology, and it is critical that this tension is taken into account in designing interventions to try to optimize prescribing behaviours. There is potential value in considering channels and mechanisms through which the risk perception of AMR could be amplified [63] and made more immediate — particularly given that prescribers are often unaware of the existing scale of AMR at the present time — and that efforts to optimize prescribing are backed up by evidence, which is currently lacking, that this strategy is effective in slowing the development and spread of resistance. Efforts to change behaviour may also need to consider how to make visible, and reward, conservative prescribing, and how to manage perceptions of risk associated with decisions not to prescribe; for example, through organizational protection from personal litigation. Clearly, developing technology to support improved diagnostic testing, and ensuring that resources are committed to the provision of microbiology services in LMICs in particular, will also play an important role in reducing the extent to which antibiotic prescribing decisions have to be made under conditions of uncertainty. In fact, improved access to expert support from microbiology services and pharmacists was the only facilitator for more optimal prescribing suggested consistently by study participants [28,31,35,38,45].

Making the case for changing behaviour to address the threat of AMR is also hampered by the fact that practitioners tend to downplay the risk of AMR in relation to their individual prescribing decisions and their own organization, and to characterize it as a problem caused by others [17,64,65]. Feedback on prescribing patterns may help drive a recognition of personal responsibility. Hospital staff may feel that they have good reason to look elsewhere for the solution to the problem, including antibiotic use in the community and in primary care; this is a particular problem in many LMICs, with non-prescription antibiotic use accounting for between 19% and 100% of antimicrobial use outside of northern Europe and North America [66]. Structures to enable cross-sector cooperation between community organizations, primary and secondary care providers, and private and public sector healthcare providers may be a partial answer to this problem [67]. Overall, tackling AMR in LMICs needs a more complex approach than in more developed countries; any interventions for behavioural change in prescribing also need to be accompanied by a tightening of antibiotic sales regulations and improvements of general hygiene levels.

This review is limited by the scope and scale of qualitative research on perceptions of AMR and antimicrobial prescribing that could be drawn upon in the analysis and synthesis. The majority of the included papers focused on barriers to changing antibiotic prescribing behaviour; few qualitative studies that looked at hospital staff perceptions of resistance were identified, although the interpretation of the qualitative data aligns with findings from survey studies [68–70]. All papers that met the inclusion criteria were included, but the quality of the included papers was variable and some contributed more relevant findings to the synthesis than others. Some of the studies included non-prescribers such as nurses and pharmacists, and these were drawn upon for additional insights into the perceptions and actions of prescribers, as opposed to exploring the diverse perceptions across different staff groups. The focus of this review was on individual perceptions; as such, the authors did not set out to study the broader cultural and contextual influences on antibiotic use [71], although the findings highlight how the social, organizational and national healthcare context can impact on perceptions of immediate and long-term risks, and commitment to and possibilities for preventative action against AMR.

Although qualitative studies from 13 different countries were identified, the majority of qualitative research on antibiotic prescribing in hospitals comes from highly developed nations such as Australia, the UK and the USA. In fact, 12 studies [7,22,25–28,36,40,42–44,52] included in this review were co-authored by a single research group based in Australia, which could have led to a bias in the results and conclusion due to the disproportionate representation of Australian samples in this review. Only six studies of developing countries matched the inclusion criteria for this review, most of which focused on South-east Asia. The very different prescribing contexts in LMICs, which can include unregulated antibiotic availability and severely limited resources for diagnostic testing and monitoring of patients [72], shape the way that risks are framed and the way they can be managed. Surprisingly, no study to date has conducted a direct cross-cultural comparison of antibiotic prescribing decisions, and how these are impacted on by context, and the vast majority of studies continue to focus on industrialized nations. Future studies should address this research gap by conducting carefully designed cross-cultural research projects comparing countries of varying development levels across different continents.

The vast majority of research on antibiotic prescribing has been conducted in public hospitals, despite the fact that countries such as the USA and many developing countries have a large sector of privately funded health care. The current review demonstrated important sector-specific pressures and incentives that shape prescribing decision-making, related to prescriber autonomy, patient demand and competition between private healthcare facilities, which could strongly drive up antibiotic prescribing rates. Further research into changing prescriber behaviour in the specific context of private healthcare provision would be of value [73].

In conclusion, AMR is a global health challenge that needs to be addressed urgently; optimizing the use of antibiotics in hospital settings is an important element of strategies for preserving antibiotics for the future and limiting the growth of resistance. Despite widespread recognition of the potential severity of AMR, commitment to efforts to optimize antibiotic prescribing by hospital prescribers is undermined by a lack of personal susceptibility and scepticism about the benefits of this approach as a preventative action. Over-prescription of antibiotics reflects prescribers' focus on minimizing short-term individual risk in their day-to-day prescribing decisions. Previous research [7,40] has identified that perceptions of clinical uncertainty, and fear of immediate risks, drive over-use of antibiotics; this review further develops the role of risk perceptions in antibiotic use by highlighting the way in which individual prescribers perceive, manage and balance different risks in their decisions about antibiotic prescribing. In developing interventions to reduce the threat of AMR by optimizing antibiotic prescribing, there is a need to consider the tensions between immediate individual risks and long-term collective risks, and consider how risks can be changed to shift practice; one way of achieving this could be to highlight existing individual risks from over-prescribing, such as side effects and increased levels of individual resistance levels, which are often downplayed. There is also a need to explore approaches to promoting cooperative action between organizations, and to develop mechanisms for feedback to prescribers about prescribing patterns, as well as evidence of the impact of improved antibiotic prescribing on the development and spread of resistance.

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None declared.

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